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TRANSLATOR'S DECLARATION

I, Wolfgang G. Fasse, having an office at: 60G Main Road North, Hampden, Maine, 04444-0726, U.S.A. and a mailing address: P. O. Box 726, Hampden, Maine, 04444-0726, USA solemnly declare:

that I am fully conversant and knowledgeable in the German language to fluently read, write, and speak it, I am also fully conversant and knowledgeable in the English language;

that I have, to the best of my ability, prepared the attached accurate, complete and literal translation of the German text of:

INTERNATIONAL APPLICATION NO PCT/DE2003/003477
INTERNATIONAL APPLICATION FILED: October 21, 2003

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: April 22, 2005

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ACCURATE AND LITERAL TRANSLATION OF THE PCT NATIONAL PHASE APPLICATION PCT/DE2003/003477 FILED ON OCTOBER 21, 2003 IN THE GERMAN LANGUAGE

Apparatus for Producing Water on Board of an Aircraft

The invention relates to an apparatus for producing water on board of an aircraft while using one or more fuel cells, wherein a partial or complete integration of a water production unit in the form of one or more high temperature fuel cells into an aircraft engine is provided in such a manner that the combustion chambers of the aircraft engine are replaced completely or partially by the high temperature fuel cells and thus either supplementing or completely replacing the process that takes place in the conventional type combustion chambers.

European Patent Publication EP 957,026 A2 discloses an energy supply unit on board of an aircraft for substituting a main propulsion plant, an auxiliary power unit, a ram air turbine or a nickel cadmium (NiCd) battery. A fuel cell serves for producing d.c. current whereby exhaust air of the aircraft air-conditioning plant or external air of the aircraft are used as air supply for the fuel cell. Water is recovered from the fuel cell exhaust air for the water supply of the aircraft. Subsequently the fuel cell exhaust air is discharged to the aircraft surroundings. This also applies to the hydrogen emanating from the fuel cell. A water production is performed by a condenser arranged in the aircraft outlet.

European Patent Publication EP 967,676 A1 describes a jet engine having fuel cells integrated into the combustion chambers, wherein the fuel cells are arranged on the combustion chambers, contrary to the teaching of the new main claim as seen from the enclosure, wherein the combustion chambers are partially or completely replaced by the high temperature fuel cell or cells. In the prior, known propulsion plant the process of the propulsion plant is merely used for the operation of the fuel cell.

Thus, it is the object of the invention to provide an apparatus of the type mentioned above in which a fuel cells gas turbine combination is provided for the exclusive operation with hydrogen and air oxygen, as a propulsion plant and/or as auxiliary power unit for the water and pressurized air supply of the cabin and for current generation.

This object has been achieved according to the invention in that the high temperature fuel cells are constructed as the type: solid oxide fuel cell (SOFC) or molten carbonate fuel cell (MCFC), or are of a type comparable in power and temperature level; that pure hydrogen is supplied to the anode side of said high temperature fuel cells, that air is supplied to the cathode side of the high temperature fuel cells, that a mixture of hydrogen and air is supplied to the combustion chambers, that at least the hydrogen supply is constructed for a closed loop control or can be shut off completely, and that a single stage or multistage turbine is connected downstream of the anode side

of the high temperature fuel cell, said turbine converting the thermal energy of the anode exhaust gas into rotation energy.

Embodiments of the invention are described in the dependent claims 2 to 24.

It is provided to thereby replace at least one, preferably however, several combustion chambers by one or more high temperature fuel cells. In distinction to the mentioned subject matter at least one or more combustion chambers are retained for combusting a hydrogen water mixture. The combustion chambers and the high temperature fuel cells are preferably arranged in alternating succession as a ring shape around the shaft or shafts of the gas turbine.

The combustion chambers serve for starting the gas turbine and the high temperature fuel cells and for temporarily increasing the air throughput of the gas turbine e.g. for starting of an aircraft. The thermal energy of the high temperature fuel cell is used exclusively for generating the air throughput during continuous operation. The water generation takes place at the anode side i.e. at the hydrogen side of the high temperature fuel cell. This so called anode exhaust gas consists of 100% water steam (superheated steam) when the supplied hydrogen is completely transformed. This superheated steam is fed through a turbine where the steam is cooled by expansion whereby thermal energy is converted into rotation energy of the turbine shaft. This rotational energy is sued in a compressor for generating the

pre-pressure that is required at the hydrogen side for the high temperature fuel cell.

The water vapor is eventually condensed out in a further process stage to obtain pure H_2O, that is, distilled water. This water is supplied to the different consumers or to a salination unit to produce drinking water. Gray water becoming available is collected in a collecting container in the same way as the water proportion discharged when dehydrating black water. The water quantities are evaporated in an evaporator operated by the heat available from the water condensation process and supplied together with the steam proportion from the anode exhaust gas of the high temperature fuel cell, not needed for water generation, to the second turbine stage of the gas turbine. On the air side a so-called fan sucks-in external air and/or cabin exhaust air. During normal operation this fan is driven by the second turbine stage, during starting by an electric motor. The air passing through the fan is first compressed by a compressor arranged downstream. The air is then further compressed in a further compressor for the combustion chambers and for the air sides of the high temperature fuel cell. The thermal energy introduced through the combustion chambers or the high temperature fuel cell first drives the first turbine stage and, following the above described introduction of gray water into the hot exhaust air flow, the second turbine stage. The number of the compressor stages, of the turbine stages, of the combustion chambers and of the high temperature fuel cells can be varied as desired with regard to different types.

The advantages of the apparatus according to the invention reside in the following:

a) flexibility with regard to short duration power demands,

b) high integration of the individual process steps,

c) high purity of the generated water,

d) high system efficiency and

e) a weight reduction.

The drawing illustrates an example embodiment according to the invention. The single Fig. shows a water generation system including a tank for liquid hydrogen. Thus, a use in a so-called "cryoplane" is particularly advantageous. As can be seen in the drawing, a high temperature fuel cell 7 replaces partially a combustion chamber 7A of an aircraft propulsion plant 2. Pure hydrogen is supplied to the anode side and air is supplied to the cathode side of the high temperature fuel cell 7, while a mixture of hydrogen and air is supplied to the combustion chamber 7A, whereby at least the hydrogen supply is constructed to be controllable in closed loop fashion or to be completely shut-off. A single stage or multistage turbine 16 is connected downstream to the anode side of the high temperature fuel cell 7. The turbine 16 converts the thermal energy of the anode exhaust gas 35 into rotation energy. Fuel cells of the type solid oxide fuel cell (SOFC) or molten carbonate fuel cell (MCFC) or of a type comparable with regard to power and temperature may be used.

A condensation process 18 is connected downstream of the high temperature fuel cell 7. The process 18 condenses water out of a portion of the anode exhaust gas 35 of the fuel cell 7. Further, the high temperature fuel cell 7 may be pressurized on both sides, on the one hand, on the air or oxygen side and on the fuel or hydrogen side, on the other hand, whereby equal or even unequal pressures are permissible on the anode side and on the cathode side. Using liquid or gaseous hydrogen is possible. Liquid hydrogen 1 can be evaporated prior to entering the high temperature fuel cell 7 or the combustion chamber 7A, whereby the evaporator 17 may be operated with the process heat of the anode exhaust gas condenser 18. A special embodiment of the apparatus according to the invention is characterized in that the evaporator 17 is arranged in a ring shape around the condenser 18 or circularly inside the condenser 18 whereby the evaporator is constructed as a pipe bundle heat exchanger. In this case also at least a portion of the condensation process 18 can be operated with cooling air 19.

It is possible to collect used water as well as not needed condensate in a container 32. The air 20 that was heated in the condensation process 18 is advantageously used for evaporating the gray water in a separate container 33 into which the gray water is fed by a pump 37, whereby a filter is provided for retaining solid and suspended materials. Water having a distilled quality is taken from the condensation process 18 and distributed in such a manner that galleys 23, hand wash basins 24 and the showers 25 receive drinking water that has been

generated by adding a dose of salt 23, while toilets 27 and the air humidification 26 are supplied with distilled water. The turbine stages 8, 9 can drive the compressor stages 5, 6 as well as the fan 11, whereby the compressor stages 5, 6 pressurize the air side of the high temperature fuel cell 7 and of the combustion chamber 7A. The air throughput 3 of the fan 11 can be used either for propulsion in an engine or in an APU for pressurizing the compressed air systems and/or of the air conditioning. For this purpose respectively one fan 11 is coupled with a first compressor stage 5 and a second turbine stage 9 and a second compressor stage 6 and a first turbine stage 8 that run on coaxial shafts one within the other and at different revolutions per minute. The number of coaxial shafts running one within the other is constructed as desired.

The waste water is collected in a collection tank 28 and completely or partially dehydrated at 30. The water proportion thus gained is fed to the gray water collection tank 32. It is of special advantage:

that the apparatus can also be operated without dispensing water to a water system,

that the combustion chambers and the high temperature fuel cells can be operated separately and in any desired combination with one another; and

that in a separate operation of combustion chambers or high temperature fuel cells 7 individual combustion chambers or high temperature fuel cells can be switched off.